WHAT IS CLAIMED AS NEW AND DESIRED TO BE SECURED BY
LETTERS PATENT OF THE UNITED STATES IS:

1. An atomic force microscope, comprising:

a scanning mechanism;

light source not moved by the scanning mechanism;

a cantilever moved by said scanning mechanism so that
said cantilever may be scanned over a fixed sample;

a stylus mounted on said cantilever;

an optical assembly mounted on said scanning mechanism to
guide a light beam emitted from said light source to follow
substantially a fixed point on said cantilever during movement
of said scanning mechanism; and

a position detector which receives a reflected light beam
from said cantilever and detects a deflection of said
cantilever.

2. An atomic force microscope as recited in Claim 1,
wherein said optical assembly guides said light beam onto a
fixed point on said cantilever during a scan of said scanner
of at least 30 μm.

3. An atomic force microscope as recited in Claim 1,
wherein said scanning mechanism comprises a piezoelectric tube
scanner and said optical assembly is mounted in said tube
scanner.

4. An atomic force microscope as recited in Claim 1,
wherein said scanning mechanism comprises at least one
piezoelectric tube, where said at least one piezoelectric tube
has an asymmetric cutout.

5. An atomic force microscope as recited in Claim 1, wherein said scanning mechanism comprises:

a piezoelectric tube scanner; and

a mounting member attached to said tube scanner and made of piezoelectric material, said cantilever being attached to said mounting member.

6. An atomic force microscope as recited in Claim 3, further comprising an optical mirror mounted in or in the vicinity of said tube scanner for receiving a light beam from said light source and directing said light beam to said optical assembly.

7. An atomic force microscope as recited in Claim 1, wherein said optical assembly comprises a steering lens.

8. An atomic force microscope as recited in Claim 1, further comprising:

an optical microscope; and

an optical beam splitter or dichroic mirror mounted to receive a light beam guided by said optical assembly and direct light reflected from said cantilever and sample to said optical microscope.

9. An atomic force microscope as recited in Claim 1, further comprising:

a second position detector; and

a beam splitter for directing a portion of light emitted from said light source onto said second position detector,

wherein said beam splitter is mounted between said optical assembly and said cantilever.

10. An atomic force microscope as recited in Claim 1, further comprising a lens mounted between said light source and said scanning mechanism.

11. An atomic force microscope as recited in Claim 1, wherein said optical assembly comprises means for producing a point source of light between a fixed end and a free end of said scanning mechanism.

12. An atomic force microscope as recited in Claim 11, wherein:

said scanning mechanism comprises a piezoelectric tube scanner; and

said optical assembly comprises a focus lens mounted at an arbitrary position, and a steering lens mounted in or alongside said scanner, said point source being formed between said focus lens and said steering lens.

13. An atomic force microscope as recited in Claim 12, wherein said focus lens and said steering lens focus an image of said point source on said cantilever.

14. An atomic force microscope as recited in Claim 12, further comprising a steering system for moving a position of the point source in the lateral direction, but maintaining an essentially fixed vertical position, keeping a vertical distance between said point source and said steering lens substantially constant.

15. An atomic force microscope as recited in Claim 12, wherein a distance moved by said steering lens during scanning of said cantilever is Δo, a distance moved by said image during said scanning is Δi, y_i is a distance between said steering lens and said image, and y_o is a distance between said steering lens and said point source, a magnification of said optical assembly $M_l = y_i/y_o$, and a mechanical magnification of said system M_s is chosen such that:

$$M_s = \Delta i/\Delta o = 1 + M_l.$$

16. An atomic force microscope as recited in Claim 1, wherein said optical assembly comprises:

means for forming an object using said light beam; and

a lens adapted to focus said image on said cantilever; wherein a distance moved by said lens during scanning of said cantilever is Δo, a distance moved by said image during said scanning is Δi, y_i is a distance between said lens and said cantilever, and y_o is a distance between said lens and said image, a magnification of said optical assembly $M_l = y_i/y_o$, and a mechanical magnification of said system M_s is chosen such that:

$$M_s = \Delta i/\Delta o = 1 + M_l.$$

17. An atomic force microscope as recited in Claim 1, wherein said optical assembly comprises:

a first lens for focussing light from said light source to a point source between a fixed end and a free end of said scanning mechanism; and

a steering lens mounted between said point and said cantilever.

18. An atomic force microscope as recited in Claim 1, wherein said light source comprises a laser which emits a parallel laser beam; and

wherein said optical assembly comprises a lens mounted on said scanning mechanism at a point that is at least 70% of the distance from a fixed end of said scanning mechanism to said cantilever.

19. An atomic force microscope as recited in Claim 1, wherein said optical assembly comprises:

a fixed lens which weakly focusses light from said light source into a beam; and

a steering lens mounted between said fixed lens and said cantilever, that forms a focused spot on the cantilever.

20. An atomic force microscope as recited in Claim 1, wherein said optical assembly comprises a mirror mounted on said scanning mechanism.

21. An atomic force microscope as recited in Claim 20, wherein said mirror is mounted on said scanning mechanism such that, during movement of said scanning mechanism, the light beam reflected off said mirror will strike substantially a fixed spot on said cantilever, or track the motion of said cantilever in one direction.

22. An atomic force microscope as recited in Claim 1, wherein said optical assembly comprises:

a first mirror mounted on said scanning mechanism; and

a second mirror mounted on said scanning mechanism;

said first mirror being used in scans in a first direction and said second mirror being used in scans in a second direction.

23. An atomic force microscope as recited in Claim 22, wherein said first and second mirrors are mounted on said scanning mechanism such that, during movement of said scanning mechanism, a light beam reflected off each of said first and second mirrors will strike substantially a fixed spot on said cantilever, and track motion of said cantilever in one direction.

24. An atomic force microscope as recited in Claim 1, wherein said position detector is located at a point where all light beams reflected from said cantilever converge when said cantilever is undeflected during a full extent of movement of said scanning mechanism.

25. An atomic force microscope as recited in Claim 24, further comprising:

a second position detector; and

a beam splitter for directing a portion of light beams reflected from said cantilever onto said second position detector.

26. An atomic force microscope as recited in Claim 24, further comprising a relay lens mounted between said cantilever and said position detector for relaying light beams reflected from said cantilever to a desired location.

27. An atomic force microscope as recited in Claim 24, further comprising a relay mirror mounted between said cantilever and said position detector for relaying light beams reflected from said cantilever to a desired location.

28. An atomic force microscope as recited in Claim 1, wherein said position sensitive detector is located at or near a point where a minimum deflection is measured when said cantilever is undeflected and scanned over a full extent of movement of said scanning mechanism.

29. A method of operating a scanning probe microscope having a light source, a cantilever and an optical assembly attached to a scanning mechanism, and a position detector, comprising:

generating a light beam;

directing said light beam onto said cantilever using said optical assembly so that said light beam strikes a substantially fixed point on said cantilever during movement of said scanning mechanism; and

receiving a reflected light beam reflected from said cantilever using said position detector to detect a deflection of said cantilever.

30. A method as recited in Claim 29, further comprising:

splitting said light beam into a first beam which strikes said cantilever and a second beam which is directed to a second position detector.

31. A method as recited in Claim 29, wherein said directing step comprises:

forming a point source between a fixed end and a free end of said scanning mechanism.

32. A method as recited in Claim 31, wherein said directing step further comprises:

focusing an image of said point source on said cantilever.

33. A method as recited in Claim 31, further comprising:

moving a lateral position of said point source while maintaining a substantially fixed vertical position of said point source while scanning said scanning mechanism.

34. A method as recited in Claim 32, wherein said optical assembly comprises a focus lens, and a steering lens mounted on said scanning mechanism, said point source being formed between said focus lens and said steering lens, a distance between said steering lens and said image being y_1, and a distance between said steering lens and said point source being y_0, said method further comprising:

scanning said cantilever;

moving said optical assembly a distance Δo during said scanning;

moving said image a distance Δi during said scanning;

defining a magnification of said optical assembly as $M_l = y_1/y_0$; and

selecting a mechanical magnification $M_s = \Delta i/\Delta o = 1 + M_l$.

35. A method as recited in Claim 29, wherein said directing step further comprises:

weakly focusing said light beam into a weakly focused beam; and

focusing said weakly focused beam to a focused spot onto said cantilever.

36. A method as recited in Claim 29, further comprising:

locating said position detector at a point where all light beams reflected from said cantilever converge when said cantilever is undeflected during a full extent of movement of said scanning mechanism.

37. A method as recited in Claim 36, further comprising:

splitting said light beams reflected from said cantilever into a first beam which is directed to said position detector and a second beam which is directed to a second position detector.

38. A method as recited in Claim 29, further comprising:

determining a point where all light beams reflected from said cantilever converge when said cantilever is undeflected during a full extent of movement of said scanning mechanism;

relaying said light beams reflected from said cantilever to a desired position.

39. A method as recited in Claim 38, further comprising:

using a relay lens to relay said light beams reflected from said cantilever.

40. A method as recited in Claim 38, further comprising:

using a relay mirror to relay said light beams reflected from said cantilever.

41. A method as recited in Claim 29, further comprising:

measuring a change in said reflected light beam when said cantilever is undeflected and scanned over a full extent of movement of said scanning mechanism; and

locating said position detector at a point where said change is a minimum.